



# 6 Design Toolbox



## OVERVIEW

As described in the Design Guidance section of Chapter 5, NCDOT should update its Roadway Design Manual to include prescriptive pedestrian and bicycle design treatments and develop new Bicycle and Pedestrian Facility Design Guidelines. Existing guidance, including the new Complete Streets Guidelines, are generally high-level discussions of pedestrian and bicycle design strategies. More detail is needed for designers to clearly understand how to implement these strategies.

This chapter serves as a Toolbox to identify key elements currently missing from NCDOT guidebooks. This Toolbox will be a robust resource that helps planners and designers select appropriate facilities or treatments given the project context and the issues being addressed. FHWA's PEDSAFE and BIKESAFE toolboxes are examples of best practices for this type of resource. NCDOT's Pedestrian and Bicycle Facility Toolbox will take the best information and resources that are available nationally, and apply them to the North Carolina context.

In order to be a useful resource, the Toolbox needs to facilitate a more complex planning and design decision process. The Toolbox should emphasize that it is not always desirable or possible to just apply basic standards - factors including nearby land uses, variations in traffic speed and volumes, existing as well as projected future demand will influence the design of any given facility. The Toolbox will highlight these issues and provide an understanding of trade-offs in pedestrian and bicycle facility design.

This Toolbox of resources and treatments, intended to provide guidance for Roadway Design Manual updates, will not be a static document. The field of pedestrian and bicycle facility design is rapidly evolving, and the NCDOT design manuals should be regularly updated to reflect the latest proven designs and treatments. By providing a detailed and current Pedestrian and Bicycle Facility Toolbox, NCDOT can offer designers and planners a comprehensive resource for developing and implementing pedestrian and bicycle accommodations and improvements. Incorporation of this Toolbox into the RDM will ensure that it is used to guide design decisions on a project by project basis. In addition, projects should employ low impact development design when possible.

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## NATIONAL PEDESTRIAN FACILITY DESIGN RESOURCES

Numerous national resources exist for the design and development of pedestrian facilities. These resources are briefly outlined below.

**FHWA PEDSAFE Pedestrian Safety Guide and Countermeasure Selection System:** This interactive website allows users to select the type of problem or crash issue they are attempting to address and provides guidance on pedestrian facility types that may be appropriate. The website includes detailed descriptions of many types of facilities, including the purpose of each facility, considerations when implementing the facility, estimated costs and case studies from around the nation.

<http://www.walkinginfo.org/pedsafe/>

**Proposed Public Rights-of-Way Accessibility Guidelines (PROWAG):** Developed by the U.S. Access Board, the PROWAG provides draft accessibility guidelines for the design, construction and alteration of pedestrian facilities in the public right-of-way. The guidelines ensure that sidewalks, pedestrian street crossings, pedestrian signals and other facilities for pedestrian circulation and use constructed or altered in the public right-of-way by state and local governments are readily accessible to and usable by pedestrians with disabilities. Compliance with the accessibility guidelines will be mandatory when they are finalized and adopted.

<http://www.access-board.gov/prowac/nprm.htm>

**How to Develop a Pedestrian Safety Action Plan:** This document will help state and local officials know where to begin to address pedestrian safety issues. It is intended to assist agencies in further enhancing their existing pedestrian safety programs and activities, including identifying safety

problems, analyzing information and selecting optimal solutions. The guide also contains information on how to involve stakeholders, potential sources of funding for implementing projects and how to evaluate projects. The guide is primarily a reference for improving pedestrian safety through street redesign and the use of engineering countermeasures, as well as other safety-related treatments and programs that involve the whole community.

[http://safety.fhwa.dot.gov/ped\\_bike/ped\\_focus/docs/fhwas0512.pdf](http://safety.fhwa.dot.gov/ped_bike/ped_focus/docs/fhwas0512.pdf)

**AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities:** The purpose of this guide is to provide guidance on the planning, design and operation of pedestrian facilities along streets and highways. The guide focuses on identifying effective measures for accommodating pedestrians on public rights-of-way. Appropriate methods for accommodating pedestrians, which vary among roadway and facility types, are described in this guide. The guide also acknowledges the effect that land use planning and site design have on pedestrian mobility and addresses these topics in detail.

<http://www.walkinginfo.org/library/details.cfm?id=2067>

**FHWA Designing Sidewalks and Trails for Access:** The document is the Federal Highway Administration's two part report on pedestrian and trail accessibility. Part 1 of the Guide lays out the history and the practices of applying accessibility concepts to sidewalks and pedestrian trails while Part 2 provides recommendations on how to design sidewalks, street crossings, intersections, shared use paths and recreational pedestrian trails. Both parts of the Guide are out of print and are available online only. Since the Guide was last published in 2001, accessibility guidelines and practices and construction and maintenance techniques have evolved, and more current information may be available.



[http://www.fhwa.dot.gov/environment/bicycle\\_pedestrian/publications/sidewalks/](http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalks/)

[http://www.fhwa.dot.gov/environment/bicycle\\_pedestrian/publications/sidewalk2/](http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/)

**FHWA's Proven Safety Countermeasures:** This resource provides tested countermeasure treatments to crashes and their measure of effectiveness.

<http://safety.fhwa.dot.gov/provencountermeasures/>

## NATIONAL BICYCLE FACILITY DESIGN RESOURCES

Numerous national resources exist for the design and development of bicycle facilities. These resources are briefly outlined below.

**AASHTO Guide for the Development of Bicycle Facilities, 4th Edition:** Published by the American Association of State Highway and Transportation Officials, this guide provides information on how to accommodate bicycle travel and operations in most riding environments. The guide is intended to present sound planning and design guidelines by referencing a recommended range of design values and describing alternative design approaches. Some flexibility is permitted to encourage designs that are sensitive to local context and incorporate the needs of bicyclists, pedestrians, and motorists.

[https://bookstore.transportation.org/item\\_details.aspx?id=1943](https://bookstore.transportation.org/item_details.aspx?id=1943)

**NACTO Urban Bikeway Design Guide:** The National Association of City Transportation Officials produced this guide of “innovative” bicycle facilities based on the experience of the best cycling cities in the world. The designs in the guide were developed specifically for urban settings, since unique urban streets require innovative solutions.

Most of these treatments are not directly referenced in the current version of the AASHTO Guide, although they are virtually all permitted under the *Manual on Uniform Traffic Control Devices* (MUTCD). All of the *NACTO Urban Bikeway Design Guide* treatments are in use internationally and in many cities around the US.

<http://nacto.org/cities-for-cycling/design-guide/>

**FHWA BIKESAFE Bicycle Countermeasure Selection System:** This interactive website allows users to select the type of problem or crash issue they are attempting to address, and provides guidance on facility types that may be appropriate. BIKESAFE also includes a large number of case studies to illustrate treatments implemented in communities throughout the United States. The system allows the user to refine their selection of treatments on the basis of site characteristics, such as geometric features and operating conditions, and the type of safety problem or desired behavioral change. The purpose of the system is to provide the most applicable information for identifying safety and mobility needs and improving conditions for bicyclists within the public right-of-way.

<http://www.bicyclinginfo.org/bikesafe/>

**Bicycle Road Safety Audit Guidelines and Prompt Lists:** This FHWA guide provides information on how to conduct road safety audits and effectively assess the safety of bicyclists. The guidelines provide an overview of the Road Safety Audit process, as well as an overview of basic safety principles and potential hazards affecting cyclists. Prompt lists are provided to assist team members in considering general issues when performing a bicycle road safety audit.

[http://safety.fhwa.dot.gov/ped\\_bike/tools\\_solve/fhwasa12018/fhwasa12018.pdf](http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa12018/fhwasa12018.pdf)



**Level of Service Indicators:** Level of Service (LOS) refers to performance indicators that rate transportation system service quality from A (best) to F (worst). Level of Service has long been used for rating conditions for motor vehicle traffic, but relatively sophisticated LOS indicators now exist for bicycle and pedestrian conditions. Most important, the Multimodal LOS assesses conditions for multiple modes on a street including walking, bicycling, and public transportation. The Multimodal LOS elements have been integrated into the 2010 Highway Capacity Manual and can help agencies determine how design changes to a street or roadway impact users of different modes.

<http://www.trb.org/Main/Blurbs/164718.aspx>

<http://www.trb.org/Main/Blurbs/160228.aspx>

## Facility Design Guidelines Compliance Categories

Facility design guidelines describe the application of various facilities to roadways.

SYMBOL	CATEGORY	DESCRIPTION
◆	Included	The guidelines/standards discuss this topic and provide at least some guidance for application considerations.
◇	Experimental	The guidelines/standards discuss this treatment, and generally discourage their use outside of very specific contexts.
○	N/A	The guidelines/standards are silent to this topic. Lack of discussion is not a statement of non-compliance.

## NCDOT COMPLETE STREETS COMPLIANCE WITH NATIONAL AND STATE STANDARDS AND GUIDELINES

### FHWA Traffic Control Device/Marking Compliance Categories

The FHWA MUTCD is not a facilities manual, but rather identifies describes federally approved traffic control devices (markings, signs and signals). These devices may be in various stages of the FHWA approval process, these are identified below

SYMBOL	CATEGORY	DESCRIPTION
★★★★	Approved	The traffic control device is included or featured in the MUTCD and can be implemented at this time.
★★★	Compliant	The treatment may be implemented at this time, if MUTCD compliant signs and pavement markings are used.
★★	Interim Approval	Interim approval permits local application of new traffic control devices in accordance with prescribed guidance.
★	Included	The guidelines/standards discuss this topic and provide at least some guidance for application considerations.
☆	Experimental	The treatment may be installed with FHWA approval of a Request To Experiment (RTE), and has been done so by other jurisdictions.
○	N/A	This treatment is not considered a traffic control device and the MUTCD does not apply to this topic. Lack of inclusion should not be considered non compliance.



## Summary of Complete Streets Compliance with National and State Standards and Guidelines

	FHWA MARKING COMPLIANCE	FACILITY DESIGN GUIDELINES COMPLIANCE				
	FHWA MUTCD (2009)	AASHTO GUIDE FOR THE DEVELOPMENT OF BICYCLE FACILITIES (2012)	NACTO URBAN BIKEWAY DESIGN GUIDE (2012)	ITE DESIGNING WALKABLE URBAN THOROUGHFARES: A CONTEXT SENSITIVE APPROACH (2010)	NORTH CAROLINA BICYCLE FACILITIES PLANNING AND DESIGN GUIDELINES (1994)	NORTH CAROLINA DEPARTMENT OF TRANSPORTATION COMPLETE STREETS PLANNING AND DESIGN GUIDELINES (2012)
<b>Bicycle Focused Treatments</b>						
Shared Roadway Facilities						
Unmarked Wide Outside Lane	★★★	◆	○	○	◆	○
Signed Bike Route	★★★★	◆	○	○	◆	◆
Shared Lane Markings	★★★★	◆	◆	○	○	◆
Bicycle Boulevard	★★★★*	◆	◆	○	○	○
"Home Zone"	★★★*	○	○	○	○	○
On-Street Facilities						
Shoulder Bikeway	★★★★	◆	○	○	◆	◆
Conventional Bike Lanes	★★★★	◆	◆	◆	◆	◆
Buffered Bike Lanes	★★★★	◆	◆	○	○	○
Contra-Flow Bike Lanes	★★★★	○	◆	○	○	○
Left-Side Bike Lanes	★★★★	◆	◆	○	○	○
Advisory Bike Lane	☆	○	○	○	○	○
Uphill Bicycle Climbing Lane	★★★	◆	◆	○	◆	○
Cycle Track Bikeways						
One-Way Protected Cycle Tracks	○	◆*	◆	○	○	○
Raised Cycle Tracks (aka Raised Bike Lanes)	○	○	◆	○	○	○
Two-Way Cycle Tracks	○	◇*	◆	○	○	○
Cycle Track Mixing Zone	★★★	○	◆	○	○	○



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* The 2012 AASHTO Guide to the Design of Bicycle Facilities does not mention "cycle tracks" by name. The provided guidance discourages two-way operation of bicycles on one side of the street, such as on a two-way cycle track, but does acknowledge that "it may be better to place one-way sidepaths on both sides of the street.." p5-11						
Off-Street Bikeways						
Multi-Use Path	★★★★★	◆	○	○	◆	◆
"Sidepath"	★★★	◇	○	○	◇	◆
Bikeway Intersection Treatments						
Advance Stop Line for adjacent motor vehicle lane	★★★★★	○	○	○	○	○
Bike Boxes	☆	○	◆	◆	○	◆
Two-Stage Turn Queue Boxes	★★★★	○	◆	○	○	○
Median Refuge Island for Bicycle Use	★★★★	◆	◆	◆	○	○
Through Bike Lanes at Auxiliary Right Turn Only Lanes (aka "add lanes")	★★★★★	◆	◆	◆	◆	◆
Combined Bike Lane/Turn Lane	★★★★*	○	◆	○	○	○
Intersection Crossing Markings						
Intersection Crossing Markings (Dotted line extensions at a minimum)	★★★★*	◆	◆	◆	◆	○
Crossing Markings: Color, bicycle symbols	★★					





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Crossing Markings: Elephants Feet	○					
On-Street Bikeway Intersection Crossings						
Bicycle Signal Heads	☆	○**	◆	○	○	○
Signal Detection and Actuation	★★★★	◆	◆	◆	◆	◆
Active Warning Beacon for Bike Route crossing at Unsignalized Intersection	☆	○	◆	○	○	○
Rectangular Rapid Flash Beacon	★★*	○	◆	○	○	○
Hybrid Beacon for Bike Route Crossing of Major Street	★★★★***	○	◆	○	○	○
<p>*[use of W11-15 (bike/ped) sign is not addressed in the IA for RRBs]</p> <p>** The 2012 AASHTO Guide to the Design of Bicycle Facilities refers to the application of conventional traffic signals for bicycle-only use.</p> <p>*** when used with bicycle signal head, experimentation required</p>						
Off-Street Bikeway Midblock Crossings						
Hybrid Beacon for Off-Street Path Crossing	★★★★	◆	◆	○	○	○
Active Warning Beacon	★★★★	◆	◆	○	○	○
Rectangular Rapid Flash Beacon	★★	○	◆	○	○	○
Bicycle Signal Head	☆	○**	○	○	○	○
Additional Marking and Signing						
Bike Route Wayfinding Signage	★★★★*	◆	◆	○	◆	◆
Colored Bike Facilities	★★	◆	◆	◆	○	○

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<b>Pedestrian Focused Treatments</b>				
Pedestrian Ways				
Buffered sidewalks	○	◆	◆	◆
Pedestrian Scale Lighting	○	◆	◆	◆
Street trees	○	◆	◆	◆
ADA Curb Ramps	★★★★★	◆	◆	◆
Shoulders for Pedestrian Travel	★★★★★	◆	○	◆
Multi-Use Paths	★★★★★	◆	○	◆
"Sidepaths"	★★★★	◆	○	◆
Un-signalized Crossings				
Midblock Crossings	★★★★★	◆	◆	◆
Marked crosswalks	★★★★★	◆	◆	◆
Pedestrian Crossing Advanced Warning Signs	★★★★★	◆	◆	◆
Pedestrian bridges: overpasses and underpasses	○	◆	○	◆
In-street pedestrian crossing sign	★★★★★	◆	○	○
Advance yield/stop lines at crossings	★★★★★	◆	◆	○
Raised Crosswalk	★★★★★	◆	◆	◆
Refuge Island	★★★★★	◆	◆	◆
Two-stage Pedestrian Crossing	★★★★★	◆	◆	◆
High visibility crosswalks	★★★★★	◆	◆	◆





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Crossing Beacons for use at midblock or unsignalized crosswalks				
Pedestrian hybrid beacon	★★★★	○	○	◆
Conventional Continuous Flashing Warning Beacon	★★★★	◆	◆	○
Active Warning Beacons	★★★★	○	◆	◆
Rectangular Rapid Flash Beacon	★★	○	○	◆
Signalized Intersections				
Pedestrian Countdown Signal Head	★★★★	◆	◆	◆
Pedestrian pushbutton actuators	★★★★	◆	◆	○
"No turn on red" sign	★★★★	◆	◆	○
Leading pedestrian interval	★★★★*	◆	○	○
General Roadway Design				
Median island	★★★★	◆	◆	◆
Curb Extension	○	◆	◆	◆
Curb radius reductions	○	◆	◆	◆
Sight distance considerations	○	◆	◆	◆
Narrow (10') Travel Lanes	○	○	◆	◆
Road Diet Conversions	○	○	◆	◆
Single-Lane Roundabouts	★★★★	◆	◆	◆
Multi-lane roundabouts	★★★★	◆	◆	◆

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Access Management				
Pedestrian-Friendly Driveways	○	✦	✦	○
Consolidate driveways	○	✦	✦	○
Right-in, right-out Channelization	○	✦	○	○
Transit Stop Considerations				
Best practice for transit stop placement	○	○	✦	✦
Concrete pads	○	✦	✦	✦
Benches and shelters	○	✦	✦	✦
Lighting	○	○	✦	✦
Other				
Low Impact Development/ Green Infrastructure	○	○	✦	✦
Pedestrian Wayfinding Signage	○	○	○	○
Block Length	○	○	✦	✦
Traffic Calming				
Mini traffic circles	★★★★	✦	○	○





## PEDESTRIAN AND BICYCLE FACILITIES IN THE NCDOT COMPLETE STREETS PLANNING AND DESIGN GUIDELINES

NCDOT adopted a Complete Streets policy in July 2009. The policy directs the North Carolina Department of Transportation (NCDOT) to consider and incorporate all modes of transportation when building new projects or making improvements to existing infrastructure. In June 2012, NCDOT published the *Complete Streets Planning and Design Guidelines* to provide guidance on how to implement the 2009 Complete Streets policy. The Guidelines include a number of pedestrian facilities and treatments that are detailed below.

### Pedestrian Facilities and Treatments

**Sidewalk and Sidewalk Buffer Zones:** Sidewalks are the primary mode of pedestrian travel in most non-rural areas and are a crucial element in any pedestrian network. Sidewalks should be part of a continuous network, connected with crosswalks and separated from traffic with a buffer. Sidewalks are provided on both local and state-owned roads in North Carolina, and should be regularly included as part of ongoing private development.



A buffer zone is a strip of land that separates vehicular traffic from the sidewalk or other pedestrian facility. A pedestrian's safety and comfort in the roadway environment is significantly affected by the width and quality of the buffer between the sidewalk and the roadway, especially on streets with heavy traffic volumes. A minimum buffer zone of six to eight feet is desirable, and will vary with the street type and surrounding land uses.

**Multi-use Path:** A multi-use pathway is physically separated from motor vehicle traffic, and can be either within the highway right-of-way or within an independent right-of-way. Multi-use pathways include sidepaths (in the roadway right-of-way), rail-trails (along or within existing or former railroad right-of-way), greenway trails (within natural corridors) or other paved facilities built for bicycle and pedestrian traffic.

Multi-use path projects should employ low impact development design, when possible, including being an adequate distance from streams (The NCWRC recommends that greenway trails be at least 100 feet from streams). As with every project, the benefits and trade-offs should be considered.



**Pedestrian Lighting:** Lighting should be provided near transit stops, commercial areas, or other locations where night-time pedestrian activity is likely. Pedestrian-scale lighting such as street lamps helps to illuminate a sidewalk, and improves pedestrian safety and security.



**Pedestrian Crossings:** Pedestrian crossings and/or crosswalks are another crucial element in any pedestrian network. Crosswalks are used to alert motorists to locations where they should expect pedestrians and to identify a designated crossing location for pedestrians. A crosswalk may be marked or unmarked since, legally, crosswalks exist at all intersections, unless specifically prohibited. Crossing treatments vary depending on a number of factors, including nearby land uses, transit stop locations, and characteristics of the street.



**Curb Extensions:** Curb extensions (also called bulb-outs or bump-outs) are extensions of sidewalks that narrow the street, increase pedestrian visibility, and decrease pedestrian crossing distance. They are an element of traffic calming that prioritizes pedestrian safety, reduces vehicle speeds, and serves to protect on-street parking. Curb extensions should however not intrude into a bicycle lane.



**Paved Shoulders:** In rural areas, shoulders may be the only pedestrian facility. Wide shoulders on rural roads allow pedestrians to travel along a gravel and sometimes paved surface in a separate space from traffic. Paved shoulders are much preferred over gravel, and offer numerous benefits to all users of the roadway including bicyclists.





## Bicycle Facilities and Treatments

**Signed Bike Route:** Signed bike routes help bicyclists to navigate lower-volume street networks. Bicycle signage is an important element of bike routes that alerts motorists to the presence of bicycle traffic while providing information to bicyclists.



**Shared-Lane Markings:** Shared lane markings (also known as “sharrows”) have become more popular as a pavement marking treatment to help align cyclists properly within more complex, urban landscapes that may feature on-street parking, a variety of lane widths, and other factors. Additionally, sharrows help remind motorists of the potential presence of cyclists and their right to be in the main travel lane with automobile traffic.



**Paved Shoulders:** In many rural areas, four-foot-wide paved shoulders are the typical treatment for accommodating bicyclists. Four-foot-wide paved shoulders allow bicyclists to travel on a paved surface adjacent to through traffic, if desired. Where speeds are 55 mph and above, five-foot-wide or wider paved shoulders are preferred. Paved shoulders are not preferred by some cyclists since the additional separation sometimes does not allow the surface to be ‘swept’ clear of debris by the passage of motorists.



**Bicycle Lanes:** Dedicated bicycle lanes are the preferred option to provide for the greatest variety of cyclists on streets, particularly those streets with higher volumes and speeds. Bicycle lanes are the backbone of a complete bicycle network, as they visually distinguish a bicycle-only travel lane in which a cyclist does not have to maneuver around motor vehicles and vice versa. Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions. Bike lanes are typically used in curb-and-gutter contexts where the number of driveway cuts is lower. A more recent development is the use of green pavement markings to delineate driveway openings or the full length of a bicycle lane so as to further separate

a cyclist – at least perceptually – from adjacent motorized traffic. Bicycle lanes often have similar maintenance issues as paved shoulders.



**Multi-Use Paths:** A multi-use pathway is physically separated from motor vehicle traffic, and can be either within the highway right-of-way or within an independent right-of-way. Multi-use pathways include sidepaths (in the roadway right-of-way), rail-trails (along or within existing or former railroad right-of-way), greenway trails (within natural corridors) or other paved facilities built for bicycle and pedestrian traffic. Multi-use paths provide the maximum protection from automobile traffic, except for where they cross roadways at-grade.



**Sidepath:** Sidepaths are multi-use paths that are located exclusively adjacent to a roadway, typically within the road right of way. These provide space for bicycle and pedestrian travel where on-road bicycle facilities are not feasible due to traffic volumes, speeds, or roadway configuration (such as limited access highways, for example).



**Bike Box:** A bike box is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase. Bike boxes are typically applied at signalized intersections with high volumes of bicycles and/or motor vehicles, especially those with frequent bicyclist left-turns and/or motorist right-turns. (NACTO)





**Right Turn Through Bike Lane:** Right-turn-only lanes are often used where right-turning motor vehicle volumes warrant an exclusive right-turn lane to improve traffic flow. The correct placement of a bike lane is on the left of an exclusive right-turn lane. Incorporating the bike lane to the left of the right-turn-only lane enables bicyclists and right turning motorists to sort their paths by destination in advance of the intersection, avoiding last moment conflicts. (AASHTO)



**Signal Detection and Actuation:** Bicycle detection at traffic signals is used at actuated signals to alert the signal controller of bicycle crossing demand on a particular approach. Bicycle detection occurs either through the use of push-buttons or by automated means (e.g., in-pavement loops, video, microwave, etc). (NACTO)



**Bike Route Wayfinding Signage:** Bicycle signage alerts motorists to the presence of bicycle traffic while providing information to bicyclists. Both bicycle lanes and shared lane markings should include signage, but bicycle signage that identifies a designated bicycle route can be a standalone element. Offering additional wayfinding information with bike route signs as appropriate can enhance quality of service and is particularly effective in high-tourism areas.



## Transit Facilities and Treatments

**Transit Stop Benches and Shelters:** Bus shelters provide a place protected from the elements for transit users to wait for a transit vehicle. Bus shelters should include seating, lighting, and bus information. In places where there is not enough demand or usage to justify a complete bus shelter, seating alone can improve the experience of waiting for a bus.



**Transit Stop Lighting:** Lighting enhances the visibility and safety of a transit stop. Lighting also improves the readability of transit features such as schedules.



**Transit Signage:** Signage helps transit users locate the bus stop. Signage can identify the route serving a stop and provide any additional information on the route and schedule.



## PEDESTRIAN FACILITIES NOT IN THE NCDOT COMPLETE STREETS GUIDE

Numerous pedestrian facilities and treatments exist in addition to the pedestrian facilities cited in the Complete Streets Guidance. These facilities and treatments are briefly described below and should be included in the updated Pedestrian and Bicycle Facilities Toolbox. The facilities and treatments are divided into categories, but may be appropriate to use in settings other than the category they are included within.

### Un-signalized Intersections

**Advanced Pedestrian Warning Signs:** Advanced warning signs warn motorists to be aware of pedestrians in the area. Advance pedestrian warning signs should be used where pedestrian crossings may not be expected by motorists, especially if there are many motorists who are unfamiliar with the area.





**Marked Crosswalks:** Marked crosswalks serve to emphasize the right-of-way where motorists can expect pedestrians to cross and designate a stopping or yielding location. They can also indicate optimal or preferred locations for pedestrians to cross. Marked crosswalks should often be installed in conjunction with other enhancements that physically reinforce crosswalks and reduce vehicle speeds, particularly at uncontrolled locations and on more major roads.



**Pedestrian Overpasses and Underpasses:** Pedestrian overpasses and underpasses allow pedestrians to cross streets without any conflicts with vehicles on the street. It is important to recognize and document conditions that warrant these facilities as they are not appropriate in all locations.



**Mini Traffic Circles:** Mini traffic circles are raised circular islands constructed in the center of residential street intersections (generally intended for use where streets are functionally classified as local or neighborhood streets). They reduce vehicle speeds by forcing motorists to maneuver around them.



### **In-Street Pedestrian Crossing Signs:**

In-street pedestrian crossing signs reinforce the presence of crosswalks and remind motorists of their legal obligation to yield for pedestrians in marked or unmarked crosswalks. This signage is often placed at high-volume pedestrian crossings that are not signalized.



**Advanced Yield/Stop Lines at Crossings:** At signalized intersections and midblock crossings, the vehicle stop line can be moved farther back from the pedestrian crosswalk for an improved factor of safety and for improved visibility of pedestrians. Advanced stop lines allow pedestrians and drivers to have a clearer view of each other and more time in which to assess each other's intentions. Advanced stop lines are also applicable for non-signalized crosswalks on multi-lane roads to ensure that drivers in all lanes have a clear view of a crossing pedestrian.



**Rectangular Rapid Flashing Beacons:** The RRFB is a rectangular shaped lightbar with two high intensity LED lighthoods that flash in a wig-wag flickering pattern. The lights are installed below the pedestrian crosswalk sign (located on each side of the road near the crosswalk button) and are activated when a pedestrian pushes the crosswalk button. The lights flash for a set time while the pedestrian crosses the street. At all other times the lights are dark.



**Right-in, Right-out Channelization:** Right-in, right-out refers to access management for streets or driveways where the only movements allowed are right turns. Right-in, right-out designs can improve conditions for pedestrians by reducing the number of potential conflicts between motor vehicles and pedestrians. Because vehicles will only be coming from one direction, it is easier for pedestrians to watch for approaching vehicles and to be sure that the vehicle operator sees them before proceeding.





## Signalized Intersections

**Pedestrian Signal Head:** Pedestrian signal heads indicate to pedestrians when they should cross a street. Pedestrian signal indications should be used at traffic signals wherever warranted, according to the MUTCD. The use of WALK/DON'T WALK pedestrian signal indications at signal locations are important in many cases, including when vehicle signals are not visible to pedestrians, when signal timing is complex (e.g., there is a dedicated left-turn signal for motorists), at established school zone crossings, when an exclusive pedestrian interval is provided, and for wide streets where pedestrian clearance information is considered helpful. Countdown signals that indicate the amount of time pedestrians have remaining to cross the street should be installed with all new or replacement signals. Signalization may also be audible to those who are sight-impaired.



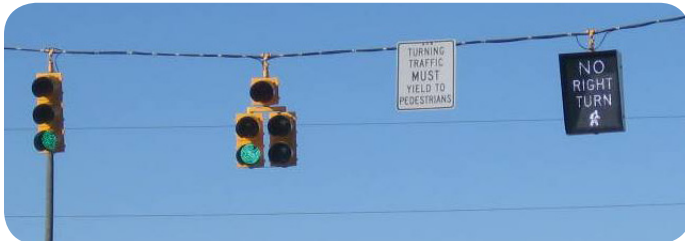
**Pedestrian Pushbutton Actuators and Pedestrian Detection Systems:** In locations where pedestrian signals are not automatically actuated during each signal cycle, pushbutton actuators should be provided to allow pedestrians to “call” the signal. However, since pedestrian pushbutton devices are not activated by about one-half of pedestrians, automated pedestrian sensors that detect the presence of pedestrians and trigger the pedestrian signal should also be considered. Manual pedestrian signal actuators should only be installed where pedestrian traffic is expected to be low to intermittent.



**Right Turn on Red Restrictions:** Prohibiting RTOR should be considered where and/or when there are high pedestrian volumes. This can be done with a simple sign posting, although there are some options that are more effective than a standard sign. For areas where a right-turn-on-red restriction is needed during certain times, time-of-day restrictions may be appropriate.



**Leading Pedestrian Interval (LPI):** A LPI gives pedestrians an advance walk signal before the motorists traveling adjacent to them get a green light, giving the pedestrian several seconds to start in the crosswalk where there is a concurrent signal. This makes pedestrians more visible to turning motorists and makes motorists more likely to yield to them. This advance crossing phase approach has been used successfully in several U.S. cities for decades and studies have demonstrated reduced conflicts for pedestrians.



## Midblock Crossings

**Pedestrian Hybrid Beacon:** Installed at mid-block crosswalks, the Pedestrian Hybrid Beacons (PHB), formerly known as the HAWK, remains dark until a pedestrian presses a pushbutton to activate the system. When activated, the system flashes a sequence of amber warning beacons followed by red "stop" beacons, providing motorists with the message to stop. PHB systems include count-down pedestrian signal heads that indicate to pedestrians when they should cross.



**Raised Crosswalk:** Raised crosswalks are essentially speed tables with a crosswalk across them. Raised crosswalks slow traffic on the street, and can provide a more accessible crossing for disabled pedestrians depending on how the crosswalk connects to the sidewalk.





**Median or Crossing Islands:** Crossing islands—also known as center islands, refuge islands, pedestrian islands, or median slow points—are raised islands placed in the center of the street at intersections or midblock to help protect crossing pedestrians from motor vehicles. Center crossing islands allow pedestrians to deal with only one direction of traffic at a time, and they enable them to stop partway across the street and wait for an adequate gap in traffic before crossing the second half of the street. They are a proven crash reduction device for pedestrians. Some of them can be designed so they are staggered or angled across a median causing pedestrians to face traffic as they are approaching the crossing from the median to street side. At signalized intersections, median islands provide a waiting place for pedestrians who may not be able to cross the full intersection during one signal cycle. Islands should always be ADA compliant.



**Two-Stage Crossing:** Two-stage crossings utilize a refuge island to allow pedestrians to cross a street in two stages. The refuge islands may be medians islands between opposing directions of traffic or “pork chop” islands between turning

and through lanes. By providing an island, pedestrians who cannot make the crossing in a single signal cycle can wait for the next signal to complete their crossing.



## Pedestrian Paths / Sidewalks General

**Street Trees:** Street trees are planted in the buffer area between the street and the sidewalk. Street trees provide a number of benefits including providing a physical barrier between pedestrians and the street, providing shade, visually narrowing the street which may slow traffic, and improved aesthetics. A context-sensitive approach should be used when selecting street tree varieties to ensure they can survive and not damage surrounding sidewalks or streets. Wider buffer widths can allow for larger trees.



**Curb Ramps:** Curb ramps provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, and also for pedestrians with mobility impairments who have trouble stepping up and down high curbs. Curb ramps must be installed at all intersections and midblock locations where pedestrian crossings exist, as mandated by federal legislation (1973 Rehabilitation Act and 1990 Americans with Disabilities Act). In most cases, separate curb ramps for each crosswalk at an intersection should be provided rather than having a single ramp at a corner for both crosswalks. All newly constructed and altered roadway projects must include curb ramps. In addition, all agencies should upgrade existing facilities.



## Access Management

**Driveway Treatments:** Several driveway designs may cause safety and access problems for pedestrians, including excessively wide and/or sloped driveways, driveways with large turning radii, multiple adjacent driveways, driveways that are not well defined, and driveways where motorist attention is focused on finding a gap in congested traffic. Examples of driveway improvements include narrowing

or closing driveways, tightening turning radii, converting driveways to right-in only or right-out only movements, and providing median dividers on wide driveways.



**Consolidated Driveways:** Driveway crossings of sidewalks often create hazards for pedestrians as motorists may not be looking for pedestrians as they pull into or out of a driveway. Where multiple driveways exist in close proximity, efforts should be made to consolidate the driveways and reduce conflict points with pedestrians.





## Roadway Design

**Chicanes:** Chicanes are used to slow traffic. Chicanes create a horizontal diversion of traffic and can be gentler or more restrictive depending on the design. Shifting a travel lane has an effect on speeds as long as the taper is not so gradual that motorists can maintain speeds. For traffic calming, the taper lengths may be as much as half of what is suggested in traditional highway engineering.



**Speed humps/tables:** Speed humps and tables are raised sections of the roadway used to slow motor vehicle traffic. Speed humps are paved (usually asphalt) and approximately 75 to 100 mm (3 to 4 in) high at their center, and extend the full width of the street with height tapering near the drain gutter or roadway striping to allow unimpeded bicycle travel. A “speed table” is a term used to describe a very long and broad speed hump, or a flat-topped speed hump, where sometimes a pedestrian crossing is provided in the flat portion of the speed table.



### **Road Diet for decreased crossing distance:**

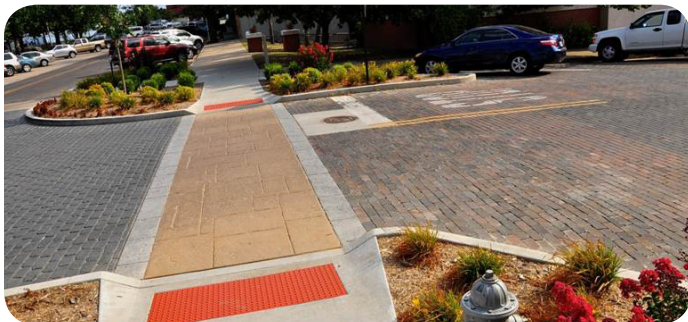
Roadway narrowing can improve conditions and safety for pedestrians by decreasing vehicle speeds and the distance pedestrians have to travel to cross the street. Roadway narrowing can be achieved by narrowing vehicle lanes, removing travel lanes, adding on-street parking, or other means.



**Curb radius reductions:** A wide curb radius enables high-speed turning movements by motorists which can result in increased crashes with pedestrians and more serious outcomes when crashes occur. Reconstructing the turning radius to a tighter turn will reduce turning speeds, shorten the crossing distance for pedestrians, and also improve sight distance between pedestrians and motorists.



**Sight distance improvements:** Improving sight distances for both pedestrians and motorists can increase pedestrian safety. Providing pedestrians with a clear view of approaching traffic at un-signalized intersections will help ensure that they have enough time to make a crossing when a gap in traffic appears. Similarly, ensuring that motorists have a clear view of pedestrians at crossings can help increase yielding behavior toward pedestrians at un-signalized crossings. Sight distance can be improved by cutting back landscaping but this can have the undesirable effect of increasing vehicular speeds.



**High visibility crosswalks:** High visibility crosswalks use specific marking patterns to increase the visibility of the crosswalk to approaching motorists. Traditional crosswalks have two lines perpendicular to the direction of motorist travel, and are often difficult for motorists to see. High visibility crosswalks use wider lines perpendicular to traffic, but also add wide lines parallel to the direction of motorist travel, which greatly increases the visibility of the crosswalk.



## Transit Stop Locations

**Concrete pads:** A solid surface waiting area, typically a concrete pad, should be provided at all transit stops. At very low usage stops, the pad alone may be sufficient to provide a waiting area for transit users, although all stops should be evaluated for the need for benches or shelters. Pads provide a stable boarding area for transit users with disabilities, particularly those who may be using wheelchairs or other assistive devices. It is critical that the pads are directly connected to nearby pedestrian facilities, and that they can be easily accessed by users with disabilities.

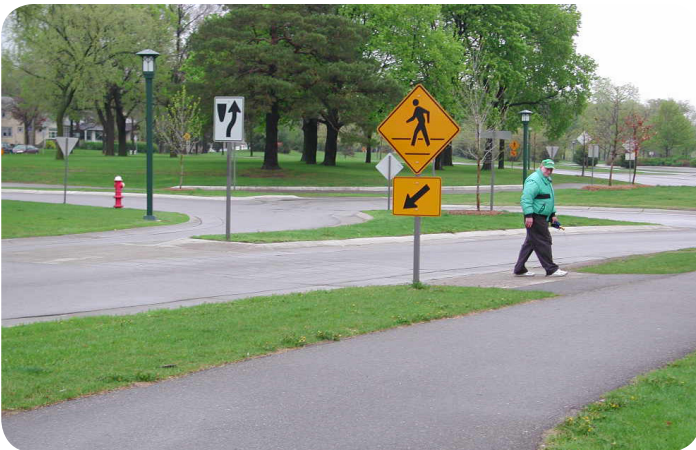






## Other Treatments

**Pedestrian Signage:** Signage helps to improve pedestrian safety by alerting motorists that pedestrians may be present. Signage can also improve the visibility of pedestrian facilities at pedestrian crossings, such as a marked crosswalk. To maintain a high quality of service, crosswalks at mid-block locations, and under some circumstances at unsignalized intersections, should include signage at a distance that allows a motorist to react and slow down if necessary.



**Block Length:** Block length can impact pedestrian safety. In particular, long blocks may encourage pedestrians to attempt mid-block crossings not at crosswalks. This increases the risk of a crash with a motor vehicle, particularly on multi-lane roadways. In new developments, overly long blocks should be avoided, and where they are included, formal mid-block crossings should be provided. In existing developments, mid-block crossings should be provided where there is reasonable pedestrian traffic and where there are specific destinations on one side of the street that encourage crossings.





## BICYCLE FACILITIES NOT IN THE NCDOT COMPLETE STREETS GUIDE

Numerous bicycle facilities and treatments exist in addition to the bicycle facilities cited in the *Complete Streets Design Guidelines*. These facilities and treatments are briefly described below and should be included in the Pedestrian and Bicycle Facilities Toolbox. The facilities and treatments are divided into categories, but may be appropriate to use in settings other than the category they are included in.

### Shared Roadway Facilities

**Unmarked Wide Outside Lane:** Lane widths that are 14 ft (4.3 m) or greater allow motorists to pass bicyclists without encroaching into the adjacent lane, and also provide a recovery area for all types of vehicles. However, bike lanes or paved shoulders are the preferred facilities on major roadways when sufficient width is available to provide those facilities. (AASHTO)



**Bicycle Boulevards:** Bicycle boulevards are streets with low motorized traffic volumes and speeds, designated and designed to give bicycle travel priority. Bicycle Boulevards use signs, pavement markings and speed and volume management measures to discourage through trips by motor vehicles and create safe, convenient bicycle crossings of busy arterial streets. (NACTO)



**“Home Zone”:** This concept originated in Denmark where it is known as a Woonerf, or “Street for Living.” These are typically streets where vehicles are slowed by placing trees, planters, parking areas and other obstacles in the street. The street is intended for local traffic only; through traffic is discouraged. This makes a street available for public use that is essentially only intended for local businesses and/or residents. (FHWA)



## On-Street Facilities

**Buffered Bike Lanes:** Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. The buffer allows for a safer and more comfortable ride for more types of bicyclists. A buffered bike lane is allowed as per MUTCD guidelines for buffered preferential lanes (NACTO)



**Contra-Flow Bike Lane:** Contra-flow bicycle lanes are bicycle lanes designed to allow bicyclists to ride in the opposite direction of motor vehicle traffic. They convert a one-way traffic street into a two-way street: one direction for motor vehicles and bikes, and the other for bikes only. Contra-flow lanes are separated with yellow center lane striping. (NACTO)



**Left-Side Bike Lane:** Left-side bike lanes are conventional bike lanes placed on the left side of one-way streets or two-way median divided streets. Left-side bike lanes offer advantages along streets with heavy delivery or transit use, frequent parking turnover on the right side or other potential conflicts that could be associated with right-side bicycle lanes. Additionally, the reduced frequency of right-side door openings lowers the risk of a cyclist getting “doored.”



**Advisory Bike Lanes:** Advisory Bike Lanes are low-speed, low traffic volume streets with one narrow lane of two-way vehicular travel (no centerline) and bike lanes on either side indicated by a dashed white line. Passing vehicles are allowed to intrude on the bike lane if bicyclists are not present. Signage is necessary to instruct drivers and bicyclists on proper operation.





**Uphill Climbing Lane:** On streets where downhill grades are long enough to result in bicycle speeds similar to typical motor vehicle speeds, a bike lane may be provided only in the uphill direction with shared-lane markings in the downhill direction. This design can be advantageous on streets where fast downhill bicycle speeds have the potential to increase the likelihood of crashes with fixed objects, particularly in locations with on-street parking. (AASHTO)



## Cycle Track Bikeways

**One-Way Cycle Track:** One-way protected cycle tracks are bikeways that are at street level and use a variety of methods for physical protection from passing traffic. A one-way protected cycle track may be combined with a parking lane or other barrier between the cycle track and the motor vehicle travel lane. (NACTO)



**Raised Cycle Track:** Raised cycle tracks are bicycle facilities that are vertically separated from motor vehicle traffic. Many are paired with a furnishing zone between the cycle track and motor vehicle travel lane and/or pedestrian area. A raised cycle track may allow for one-way or two-way travel by bicyclists. (NACTO)



**Two-Way Cycle Track:** Two-way cycle tracks are physically separated cycle tracks that allow bicycle movement in both directions on one side of the road. Two-way cycle tracks share some of the same design characteristics as one-way tracks, but may require additional considerations at driveway and side-street crossings. (NACTO)





**Cycle Track Mixing Zone:** The approach to an intersection from a cycle track should be designed to reduce turn conflicts for bicyclists and/or to provide connections to intersecting bicycle facility types. This is typically achieved by removing the protected cycle track barrier or parking lane (or lowering a raised cycle track to street level), and shifting the bicycle lane to be closer to or shared with the adjacent motor vehicle lane. At the intersection, the cycle track may transition to a conventional bike lane or a combined bike lane/turn lane. (NACTO)



**Two-Stage Turn Queue Box:** Two-stage turn queue boxes offer bicyclists a safe way make left turns at multi-lane signalized intersections from a right side cycle track or bike lane or right turns from a left side cycle track or bike lane. Two-stage turn queue boxes may also be used at unsignalized intersections to simplify turns from a bicycle lane or cycle track, as, for example, onto a bicycle boulevard. (NACTO)



**Median Refuge Island for Bicycle Use:** Median refuge islands are protected spaces placed in the center of the street to facilitate bicycle and pedestrian crossings. Crossings of two-way streets are facilitated by allowing bicyclists and pedestrians to navigate only one direction of traffic at a time. Medians configured to protect cycle tracks can both facilitate crossings and also function as two-stage turn queue boxes. (NACTO)



**Combined Bike Lane/Turn Lane:** A combined bike lane/turn lane places a suggested bike lane within the inside portion of a dedicated motor vehicle turn lane. Shared lane markings or conventional bicycle stencils with a dashed line can delineate the space for bicyclists and motorists within the shared lane or indicate the intended path for through bicyclists. (NACTO)



**Intersection Crossing Markings:** Intersection crossing markings indicate the intended path of bicyclists and alert drivers to potential bicycles in the roadway. They guide bicyclists on a safe and direct path through intersections, including driveways and ramps. They provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane. Many different crossing treatment combinations exist: dotted lines or “elephant feet” can be augmented with pavement color, bicycle symbols and/or chevron symbols. (NACTO)



**Active Warning Beacon for Bike Route Crossing at Unsignalized Intersection:** Active warning beacons are user-actuated amber flashing lights that supplement warning signs at unsignalized intersections or mid-block crosswalks. Beacons can be actuated either manually by a push-button or passively through detection. Active warning beacons should be used to alert drivers to yield where bicyclists have the right-of-way crossing a road. (NACTO)



## On-Street Bikeway Intersection Crossings

**Bicycle Signals:** A bicycle signal is an electrically powered traffic control device that should only be used in combination with an existing conventional traffic signal or hybrid beacon. Bicycle signals are typically used to improve identified safety or operational problems involving bicycle facilities or to provide guidance for bicyclists at intersections where they may have different needs from other road users (e.g., bicycle-only movements, leading bicycle intervals). (NACTO)



**Rectangular Rapid Flash Beacons (RRFBs):** RRFBs are a type of active warning beacon that use an irregular flash pattern similar to emergency flashers on police vehicles. RRFBs can be installed on either two-lane or multi-lane roadways. (NACTO)



**Hybrid Beacon for Bike Route Crossing of Major Street:** A hybrid beacon, also known as a High-Intensity Activated Crosswalk (HAWK), consists of a signal-head with two red lenses over a single yellow lens on the major street and pedestrian and/or bicycle signal heads for the minor street. There are no signal indications for motor vehicles on the minor street approaches. Hybrid beacons were developed specifically to enhance pedestrian crossings of major streets. However, several cities have installed modified hybrid beacons that explicitly incorporate bicycle movements. (NACTO)



### Off-Street Bikeway Midblock Crossings

**Hybrid Beacon for Off-Street Path Crossings, Active Warning Beacons, and Rectangular Rapid Flash Beacons:** These beacons can be applied at an off-road, multi-use path crossing where no nearby signalized intersections are present. (NACTO)



## Additional Marking and Signing

**Colored Bike Facilities:** Colored pavement within a bicycle lane increases the visibility of the facility, identifies potential areas of conflict and reinforces priority to bicyclists in conflict areas and in areas with pressure for illegal parking. Colored pavement can be utilized either as a corridor treatment along the length of a bike lane or cycle track or as a spot treatment, such as a bike box, conflict area or intersection crossing marking. (NACTO)



## CONTEXT AND DESIGN CONSIDERATIONS

The purpose of this Toolbox is not simply to provide a comprehensive listing of treatments and facilities, but to provide planners and designers with a decision matrix so they can easily select the most appropriate treatments for a given situation. A detailed discussion of the context in which it is appropriate to use each treatment and specific design elements will help guide the selection of the best treatments for each situation. Providing the following information with each item in the Toolbox will allow planners and designers to select the appropriate treatment for the specific project they are working on.

## Crash Modification Factors

Crash modification factors (CMFs) are multiplicative factors used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The CMF is multiplied by the expected crash frequency without treatment. A CMF greater than 1.0 indicates an expected increase in crashes, while a value less than 1.0 indicates an expected reduction in crashes after implementation of a given countermeasure. For example, a CMF of 0.8 indicates an expected safety benefit; specifically, a 20 percent expected reduction in crashes. A CMF of 1.2 indicates an expected degradation in safety; specifically, a 20 percent expected increase in crashes.

Many of the facilities and design treatments listed in this chapter have known crash modification factors that demonstrate a reduction in crashes when the facility is implemented. Toolbox items that have positive crash modification factors associated with them (indicating a reduction in crashes) should be highlighted as priority facilities to implement when the context and need is appropriate.

## Design Considerations

Location and context needs to be carefully examined when selecting the type of pedestrian or bicycle facilities that should be implemented in a given location. Even when considering a single street corridor, significant differences can exist from one end of the corridor to the other end, or even from block to block, that may require adjustments to the facilities being implemented. Factors such as the abutting land use, current and projected pedestrian and motor vehicle levels, the presence of schools, civic spaces, retail and other pedestrian and bicyclist attractors are some of the things that should be considered.



In addition to the design considerations cited above, the age and abilities of both pedestrians and bicyclists should be a primary consideration when selecting treatments. At a minimum, pedestrian facilities should meet all ADA requirements. Close attention should be paid to ensuring that the selected treatments meet the needs of youth, elderly and disabled pedestrians. These groups may require additional crossing time at intersections, among other design considerations.

It is important to recognize the types of bicyclists that will be served by specific facilities and ensure that facilities and treatments are provided to serve the full-spectrum of bicyclists. Bicyclists range from confident cyclists who are comfortable riding with motor vehicle traffic to more cautious cyclists who may be uncomfortable riding with much traffic to youths who may not have fully developed spatial and cognitive skills. While not every bicycle facility can serve all user types, it is important that the overall bicycle network meet the needs of all bicyclists and potential bicyclists in a community. For example, this may be accomplished by providing bicycle lanes on the main thoroughfare through a village while also providing a nearby parallel route that is comfortable and accessible for families or less confident cyclists. This parallel route may consist of a shared use path, a bicycle boulevard or another low-stress treatment. Chapters 3 and 4 of the 2012 *AASHTO Guide for the Development of Bicycle Facilities* provide significant information and context about bicycle operation and safety and the selection and design of on-road bicycle facilities.

Once specific facility types have been selected, they should be tailored for each specific location. The Toolbox should provide the basic starting point for each facility type, with minimum specifications for design, but the Toolbox should also emphasize that the minimum/standard design may not

## Additional Considerations

**Access to Transit:** Nearly all transit users are also pedestrians at some point in their trip. Sidewalk connectivity in the proximity of bus stops provides safer access for transit users, and is especially important to older residents and those with disabilities.

**Access to Trails:** North Carolina has an extensive trail network, but often these trails are not connected to destinations and neighborhoods. A network of sidewalks and on-street bicycle facilities is needed to provide better access to multi-use trail entrances.

**Access Through Construction Zones:** Construction zones can range from complete sidewalk closure to fully protected access. In May 2008, NCDOT published a Guide for Temporary Pedestrian Accommodations, which addresses issues such as American's with Disabilities Act (ADA) accessibility, safety, and the identification of temporary detour routes.

**Access Across Bridges:** Bridges can serve as either connections or barriers in pedestrian and bicycle networks. NCDOT's Bridge Policy establishes controlling design elements for new and reconstructed bridges on the state road system. It includes information to address sidewalks and bicycle facilities on bridges, including minimum handrail heights and sidewalk widths.

**Access Near Major Highways:** Freeway on-off ramp intersections present special challenges for pedestrians and bicyclists due to the often free-flow intent to accommodate turning motor vehicles. Countermeasures may include channelization islands, median island "refuges," embedded lighting at crosswalks, and tighter corner radii to slow down turning speeds. The ultimate crossing solution is a separated grade facility, either a bridge over or a tunnel/culvert structure under the crossing mainline roadway. In 1994 the NCDOT adopted administrative guidelines to consider greenways and greenway crossings during the highway planning process, so that critical corridors for future greenways will not be severed by highway construction.

be appropriate in all situations. The discussion presented for each potential facility type should be sufficient to aid an engineer's judgment as to whether a location is appropriate for the facility and considerations for its siting.

## North Carolina Case Studies and Examples

Case studies and examples from North Carolina communities should be provided with as many Toolbox items as possible. Where examples or case studies from North Carolina are not available, examples from nearby states with a similar geographic and urban/rural mix as North Carolina should be provided. Efforts should be made to include examples from a mix of urban, suburban and rural communities, and urban examples should include large cities as well as smaller villages and towns. Examples from other locations in the United States may be appropriate if they offer particularly strong examples of specific facilities.

## Urban, Suburban and Rural Considerations

The same facility may be implemented differently depending on the surrounding land use. NCDOT's road network passes through urban, suburban and rural areas, and a pedestrian or bicycle facility that is appropriate in one area may not be appropriate in another. The Pedestrian and Bicycle Facility Toolbox should note the appropriateness of each facility type for urban, suburban and rural areas as well as any special design considerations for each area type. This guidance should not be binding as there may be instances where a specific facility type is appropriate for an area it is not generally recommended for, but should allow planners and engineers to quickly ascertain which treatments and facilities are appropriate for the project area they are working on.

## Design Resources

The Pedestrian and Bicycle Facility Toolbox should identify specific design resources for each treatment or facility. The resources should primarily include national and North Carolina guidance, including the resources noted at the beginning of this document.

## Relevant Research

Details on relevant research for each item in the Pedestrian and Bicycle Facility Toolbox should be provided. This may include links to best practices for implementing specific facility types or research regarding safety improvements from specific facilities. Links to relevant research should be brief, but should note the primary conclusion of the research, and why it is important.

## CONCLUSION

A detailed Pedestrian and Bicycle Facility Toolbox will serve as a resource for planners and designers who are seeking to implement the recommendations provided in the Complete Streets Design Guidelines. The Toolbox will be incorporated within the Roadway Design Manual and will build upon national-level pedestrian and bicycle facility design resources. The Toolbox will expand upon the facilities described in the existing Complete Streets Guidelines, while also introducing emerging treatments that are being used throughout the United States.

Most importantly, the new Pedestrian and Bicycle Facility Toolbox will present context-based design considerations so that project designers are well aware of considerations such as Crash Modification Factors, relevant research and examples of communities in North Carolina that have implemented specific facilities or design treatments.





